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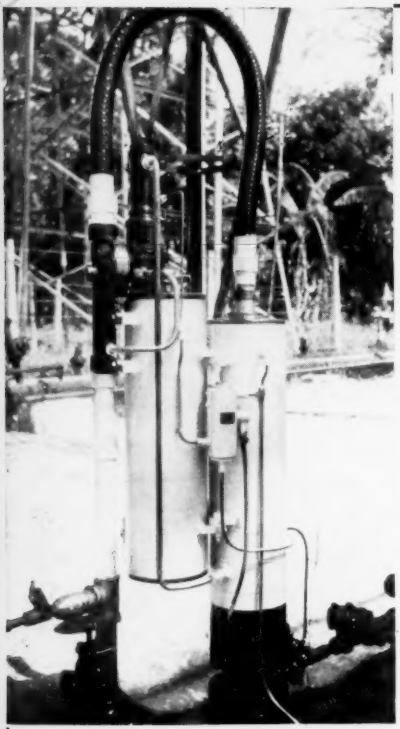

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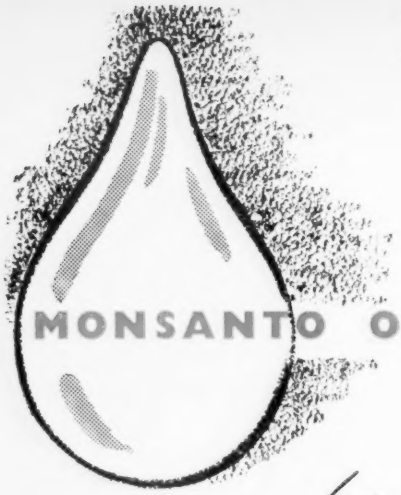

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PETROLEUM IN AGRICULTURE *

By F. W. ELLIS †

The purpose of this paper is to deal with the place of petroleum in agriculture as a whole and to examine some of the ways in which future developments in agriculture itself will have repercussions on the petroleum industry.

It was inevitable that sooner or later the world's largest primary industry would provide a large market for petroleum and the products made from petroleum.

All phases of progress brought about by the introduction of liquid fuels have their share in agricultural activities, but this paper will concern itself with the phases of petroleum usage which are more directly concerned with the business of growing food. It is convenient to consider petroleum in agriculture under two main headings:—

(1) its use in agricultural machinery;
(2) its use as an agent in crop growing.

The Use of Petroleum in Machinery

The introduction of machinery into agricultural practice has come about very rapidly during the last ten years but its real history dates from 1856, when John Fowler perfected his first steam ploughing outfit.

It will be helpful to examine the present position and see where the responsibility of the petroleum industry lies. There is much confusion between two separate and distinct subjects, the first, agricultural engineering, which is concerned with the manufacture, development and testing of the machine itself and its sister subject, farm mechanization, which is purely a problem of farm management. It is true to say that while the two subjects should run

* Paper first read to the Manchester Branch of the Institute, March 21, 1950.

† Anglo-American Oil Co. Ltd.

hand in hand, the first has a very much greater proportion of brain power and finance devoted to it than has farm mechanization. It is only through the study of farm mechanization that the proper utilization of each machine on the farm can be assessed and comparatively little useful work in this field has been done.

In the development of machinery which has to work under peculiar and exacting conditions, there is a good deal of research work for the petroleum technologist. The petroleum marketer on the other hand is more concerned with studies in farm mechanization and it is only through this channel that estimates for future requirements can be made, and special delivery and packaging problems adequately studied.

The statement has often been made that the United Kingdom has the most highly mechanized agriculture in the world. This statement is, however, based solely on the tractor population per unit of arable cultivated land and it is very doubtful if it would stand up to proper examination if the whole field of mechanization were to be considered —equipment for crop handling, and machines for lifting, shifting, and taking the back-ache out of a thousand jobs.

Britain has not yet learned to use a tractor to anywhere near its potential capacity, whereas on the North American small family farm, the tractor is regarded as a maid-of-all-work and its power exploited to a much greater extent. Hoists, saws, concrete mixers, and many other jobs are all powered through the tractor. Such a tendency is bound to spread in the U.K. when the full extent of the evil of over-capitalization on expensive machinery is realized.

A recent survey of tractor operation made by economists of the University of Nottingham shows that, in the tractors they examined, the number of hours worked per year varied between 341 and 2363. All were 4-wheeled tractors. The average for the U.K. is rather less than 1000 hours of work per year per tractor which, allowing for 300 working days, means a little over three hours work per day.

In the U.K. a total of 300,000 tractors of all types is being approached and it is probable that this figure will represent a peak unless some other unforeseen factor is introduced into the national economy.

The official census of machinery no longer provides useful information on the numbers of tractors using each kind of fuel, as the division on the census form is by type of tractor rather than by type of fuel, and development in design over the last two years has introduced a considerable overlapping between types. The census figures are, therefore, no longer a reliable guide to the fuel requirements of the industry.

The best estimate that can now be made indicates that some 50,000 petrol tractors, 230,000 kerosine tractors, and 15,000 diesel tractors are responsible for the consumption of 25 million gallons of petrol, 12 million gallons of diesel fuel, and 225 million gallons of vaporizing oil.

This indicates that £17½ million per annum is a reasonable estimate of the present petroleum market in agriculture, including an allowance for lubricating oils at the rate of 5.5 per cent of fuel usage and appropriate additions for greases and special products.

Diesel Tractors

One of the factors which will undoubtedly exercise great influence on sales of tractor fuels in the next few years is the increase in diesel-engined tractors.

Diesel tractors have not been accepted so widely nor so quickly in the U.K. as they have in most other countries. The main reason for this is that the manufacturing cost of a diesel-powered unit in the U.K. is still very high compared with that for a kerosine or petrol engine. One popular make of tractor to-day which

can be fitted either with vaporizing oil or 4-cyl diesel engine is scheduled to cost £197. 10s more with the diesel unit. The difference with some other makes is even greater, especially where a 4-cyl petrol engine is replaced by a 6-cyl diesel unit. There is no doubt that such an increase in initial cost is a very potent factor in retarding the rapid introduction of the diesel to British agriculture.

However, in spite of this, the numbers are increasing, particularly in the mainly arable districts down the eastern side of the country. It may also be that a Government-sponsored plan to reclaim a large amount of what is called marginal land on the lower hills, would call also for an increase in the heavier types of tractor, many of which would be diesel-powered.

Apart from the high manufacturing cost, there is much to be said from a technical point of view in favour of a tractor driven by a diesel unit. The three main advantages are:—

(1) *The running cost and fuel consumption is low;*

(2) *From the point of view of both maintenance costs and reliability, the diesel is attractive, particularly so in an industry where many machines have to be operated by workers who are comparatively unskilled in engineering.*

(3) *The high torque at low engine revs makes it an ideal power unit in land work.*

Artificial Drying

There is another phase of mechanization which has come to the fore during recent years, the use of fuel oils for artificial drying.

Drying in agriculture can be broadly divided into two categories: (1) Grain drying; (2) Crop or, as it is generally known, grass drying.

Grain drying is an operation complimentary to the introduction of the combined harvester and there is no doubt that the combined harvester is here to stay. There were in 1949 over 11 thousand combines at work in the U.K. and the numbers are increasing swiftly. When corn is harvested and stacked in the more traditional manner, there is no need for any artificial drying. However, in Britain grain harvested from the field in bulk or in sacks generally needs to be dried before it can be stored safely. Only in exceptional summers is it practicable to handle combined-harvested grain straight away and even in 1949 a good deal of it was dried for safety. A moisture content of about 14 per cent is usually considered to be the safe maximum for storage and it is quite common for grain from the field to contain 22-23 per cent of moisture.

How to provide the correct equipment and organization for drying grain is one of the most vexed questions in agriculture at the moment but it is certain that drying facilities will increase very rapidly and, as most types of plant require heated air, there will be an increased demand for either gas oil or the heavier fuel oil grades.

Crop or grass drying is now an established feature of the industry and there are 500 to 600 driers in operation. A reasonable estimate is that this number will increase to about 1000 by the end of 1952.

There are three main types of drying organizations to be considered:—

(1) *The drier on the farm which supplies mainly food for the stock kept on that farm;*

(2) *The co-operative drier serving a group of farms;*

(3) *The factory type of drier producing stock food for re-sale.*

The size of these driers varies enormously, but if the smallest type only—the farm drier—is considered, some kind of an estimate for fuel consumption can

be made. The farm drier producing 300 tons of material during a year and using 60 gallons of oil fuel per ton will be responsible for a consumption of some 18,000 gallons. Assuming that at present 350 plants are running on oil fuel, this gives a consumption of over 6 million gallons per annum.

This outlet is particularly interesting because of the rapidly increasing interest in the use of medium fuel oil (200 sec Redwood I at 100°F). Generally speaking, grass drying is a costly but favourable process at the present time, when considered in the light of current prices for purchased feeding stuffs. Farmers and others operating drying plants are, therefore, eager for a chance to reduce their production costs by the use of these heavier oils.

On technical grounds there does not seem to be any serious drawback to the use of 200-sec fuel for crop drying. The problems involving line heaters and burner conversion are well understood and the burner manufacturers are offering conversion units at attractive prices.

The only real disadvantage which has been suggested is the danger of these fuels rendering the finished product unpalatable to cattle through certain combustion products being deposited on the dried material when the flue gases pass through the crop. However, so far there seems to be no evidence to suggest that this happens in practice or that it is in any way an important factor.

In this connexion it is interesting to know that one of the major manufacturers has recently decided to send out all its new driers equipped for burning 200-sec fuel.

The future of crop drying in agriculture is by no means certain. At the present time, with purchased feeding stuffs for dairy cattle costing £30–£35 per ton, there is every encouragement to produce dried grass for less than half that figure, and there is little doubt that for the next few years an increase in plants for this purpose can be expected. At the same time, however, the preservation of grass and other crops by means of another process—ensiling, a controlled fermentation process—is making rapid strides. This is a very much less costly process, and one which for various reasons is becoming extremely attractive and may eventually overshadow the development of drying itself.

While it is not known exactly how many of the established drying plants are running on solid fuel and how many on oil, it is reasonably estimated that some 60 per cent of all the driers in use are oil-fired. It is also true that the majority of new plants are now being installed to run on liquid fuel.

Special Products

Special products do not always receive the attention they deserve. They are needed because of the special conditions under which agricultural machinery is expected to operate. The days when all the maintenance work could be carried out with a tin of general-purpose grease are gone.

Lubricants

The subject of detergent oils for diesel tractors is one which will need a good deal of attention. While the case for using detergent oils is fairly clear, diesel tractor drivers who have changed from straight mineral oils to detergent oils have experienced some trouble through the loosened deposits and carbon circulating in the system. These problems are well understood, but the sale of detergent oils for tractors must be accompanied by adequate technical advice on their correct use, particularly at the changeover period.

Greases

Operators of farm equipment still know far too little about greases. The modern tractor and much agricultural machinery is precision built, yet it is still quite common to find one general-purpose grease being used for water

pump glands, track rollers, and other parts which have specific requirements.

There has also been some trouble with drying plants. For instance, the fan bearings on a grass drier deal with air and flue gases at 300°–350°F and some of the pneumatic-type driers operate at temperatures up to 2000°F. It is obvious that special high-temperature lubricants are required, and technical guidance on their use is imperative.

Rust Preventives

There has been wide acceptance among farmers of petroleum-based rust preventives but once again results in some cases have been disappointing. This is mainly due to lack of adequate instructional backing for the product, which results in poor application. Generally speaking, the petroleum-based preventives are doing a useful job in the preservation of all types of farm machinery but they are still apt to be regarded by some as rust removers.

There are some particularly difficult problems which have not yet been solved. One of these is the adequate protection of machinery for handling fertilizers. Some of the available products are useful to a certain degree for this application but the corrosion effects of acid fertilizers are still one of the greatest sources of loss with agricultural machinery. Some kind of softening agent would have an immediate acceptance—as would a rust-removing compound.

There is a good deal of misunderstanding on the subject of the maintenance of farm implements and many practices which to anybody unfamiliar with farming appear to be wasteful are not considered serious by the farmer himself.

In many instances it is economically unjustifiable to make elaborate and costly preparations for housing and servicing all the machinery on a farm. It is, however, clear that with the advent of larger, more costly and in many cases self-propelled machines such as combined harvesters and pick-up balers whose initial purchase price may well be over £1000, there is every reason why proper cover should be provided and regular detailed maintenance carried out by informed operators.

Aerial Spraying

Passing reference should be made to the use of aircraft for doing various jobs in agriculture. This appears to have a great future if certain conditions are fulfilled.

One firm of spraying contractors has successfully operated helicopters for crop spraying and dusting in the past year or two, both in Britain and in East Africa.

There have been spasmodic attempts to make use of fixed-wing aircraft for sowing seeds, for spreading fertilizers, and for spraying weed killers and insecticides. Transport of stock by means of aircraft is now quite common. There is little to be said about it as the problems are similar to those of transporting any other class of goods.

The main advantage of aircraft for spreading seeds, fertilizers, etc., is that a large area can be covered in a short time. But there are several points which have to be borne in mind before wholesale use of fixed wing aircraft becomes thoroughly established. In the first place, the load which can be carried is limited. The next most important point to be considered is that the areas which lend themselves to large-scale distribution of this kind are often situated far from a suitable landing and servicing ground so that time spent in flight and preparation can often be very much greater than the time spent on the job itself.

There is also the question of evenness of distribution and wind drift to consider, and in the latter connexion there have already been many cases of litigation in the U.S.A., brought about by crop damage caused through some

chemical, distributed from an aircraft, which has drifted on to another owner's land. On this account some states in the U.S.A. have banned the use of aircraft for this purpose.

The greatest progress in the use of aircraft for agricultural purposes has been made in New Zealand and the U.S.A. In New Zealand there is a large area of hill land which it is known can be made productive by the simple spreading of superphosphate fertilizers, and the New Zealand authorities are already using the method to good effect. The New Zealand Air Force are co-operating by arranging for their pilots in training to cover the areas of agricultural importance and spread fertilizers during the course of the flight.

In the United States, in California alone in 1948, over 200,000 acres were treated with weed killer applied as a spray from aircraft.

There would not seem to be any very great prospects at the moment for treatment of this sort in the normal farming areas of the U.K. apart from the application of materials to the larger arable areas of Lincolnshire, Cambridge, etc., by helicopters and small fixed-wing aircraft. The expression normal areas is used advisedly because there is at present a great deal of interest being shown in the hill lands and areas where only marginal returns can be made. It is a distinct possibility that some government-sponsored scheme of assistance vastly greater in scope than the present scheme will be put into operation some time within the next twelve months. The necessary surveys are being made, and it is known that the total area which could be considered as potentially capable of improvement is over 16 million acres.

These are areas of extensive farming and to make them productive great quantities of lime, fertilizers, and in some cases seeds, will have to be applied. It may well be that the use of aircraft will prove a partial solution to the problems involved. Even though one half-hour's flying is required in each direction for an application taking only a few minutes, this may still be a more economic proposition than surface-hauling thousands of tons of material.

Petroleum as an Agent in Crop Growing

In considering the use of petroleum and petroleum products as agents in growing crops, the picture until recently has been somewhat confused. It now seems that there are three main channels along which development will proceed.

Petroleum itself can be an active agent for doing a job. For example, the use is now well established of petroleum white oils in insecticidal fruit and greenhouse sprays. Generally the action in this case is that the petroleum destroys the insect's eggs or clogs up the breathing apparatus of the insect itself. In some applications, there also is a toxic effect. It is, in fact, itself the killer.

The other established use for the biological application of petroleum is in the weed-killer field. It has long been known that most petroleum oils are phytocidal to a greater or lesser degree and where a complete kill is required of the green cover, i.e. on permanent ways, paths, etc., spraying with the lighter distilled grades is already widely practised. The same technique for treating citrus fruit orchards, and grapes, is widely used in California and other parts. Here also, the need is for a complete destruction of weed cover.

In agriculture, however, a far more interesting application lies in the field of selective weed killers, that is to say agents which will destroy one form of plant and leave another unharmed.

The most outstanding success to date has been achieved with carrots and other related crops.

It is now well known that in the natural order of plants known as *Umbelliferæ* there is a certain resistance to the phytocidal effects of petroleum. In this

natural order are both crops of economic importance and also many weeds, but it happens that the majority of the economic crops of this family are grown in situations where the weed members of the family are not a very serious menace. Certain types of petroleum can, therefore, be used as a spray on the growing crop to kill the weeds and to leave the planted crop unharmed.

The purely biological action of the oil is not completely understood but it appears to be tied up in some way with the aromatic compounds present. It does not appear to be correlated with the content of aromatics, as assessed by normal methods, and the indications are that the qualitative analysis of the aromatics will be more important. In fact, the problem is a good deal more complicated than was originally anticipated. Much research work of a fundamental nature is in progress in various parts of the world.

The work resolves itself into two main phases:—

(1) *Taking the various petroleum fractions apart to find out which particular compounds have a phytocidal or toxic action on the plant;*
(2) *Investigating the action of those fractions on the plant tissues themselves.*

With the first of these at least the petroleum industry has made much progress.

The two products which have received the widest acceptance for this particular application are vaporizing oil with its high aromatic content, and white spirit, now universally accepted in many parts of the U.S.A. as a standard spray in the carrot crop. The economic situation in Britain, however, makes the cost of spraying with these two fractions very heavily weighted in favour of the former product.

The second channel through which developments are liable to take place is the use of petroleum as a carrier for some other active agent. It takes some 400-500 gallons of spray, the greater part of which is water, to treat an acre of orchard. Water is heavy, and expensive to transport. Therefore, the development of sprays in which the carrier is petroleum and which, because of its greater covering and spreading effect, can be used at much smaller gallonages per acre, seems to offer a possible cost reduction which might have far-reaching effects.

Petroleum oils can also be atomized in a stream of fast-moving air and various techniques for their use in this form are at present under investigation. In such an instance, however, petroleum is merely a carrier and the active agent would be some other chemical. Further, for most applications of this sort, the oil must be biologically inert.

The third line of development is the use of petroleum as a synergist. A synergist is an agent which, through its presence, increases the potency or effectiveness of some other chemical agent. Certain forms of petroleum can be used to synergize the now widely accepted chemical hormone weed killers as well as some other chemicals used in farming.

To illustrate briefly the possible effects of the use of petroleum in agriculture through its application to a growing crop, a simple example will suffice. The amount of fuel used to prepare the land, plant, cultivate, and harvest an acre of carrots would be something in the order of 9-10 gallons. To apply vaporizing oil as a weed-control agent to the same acre could easily absorb 60 gallons.

Conclusion

In conclusion, it would be perhaps advisable to examine briefly some of the problems which present themselves to the petroleum industry and which have particular significance from the point of view of its agricultural market.

Undoubtedly the greatest is the problem of supplying to the workers in

agriculture the necessary technical information so that products can be correctly applied, handled, and stored. There is a vast amount of missionary work to be done and it is good to see that some of the distributing companies are going to considerable lengths to deal with the problem.

The second problem is a close study of the actual conditions under which petroleum products are used in farm machinery—with liaison between manufacturers on the subject of lubricating devices. The open oil hole still appears all too frequently in machines with bearings working in mud and dust, with no means of excluding either.

No real progress can be made in the field of petroleum as a crop-growing agent unless the gap be narrowed between the petroleum technologist and the biologists. It is perhaps surprising that up to the moment there is no published material dealing with investigations into the effect of petroleum on the soil itself, although it is only fair to say that the early indications are that no harm is caused and in some cases even it would appear that an improvement is effected.

* * *

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Now in its seventh year, the Scientific Film Association announces that the work it to-day carries out largely on a voluntary basis covers a very wide field. It has recently made a survey of makers and distributors of films dealing with science; it has organized conferences and shows on scientific films—of which the recent showing of films from France at the Institut Français is an example; it sends delegates to international conferences. It also carries out appraisals of new scientific films and in this connexion particularly the Institute appeals for more members to join the specialist "panels" who do the viewing of the films. Enquiries to the Association at 4 Great Russell Street, London, W.C.1.

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* * *

FACTS ABOUT CANADA

For oil and allied industries is the title of a brochure issued by The Canadian Bank of Commerce, Toronto 1, Canada. Such items as exchange control, taxation, company incorporation, leases, oil and gas conservation, customs regulations, and immigration are covered. There is a synopsis of oil exploration in Western Canada, a tabulation of details of the various oilfields, and a useful map of their location.

STEAM TURBINE LUBRICATION*

By W. E. J. BROOM (Fellow) and G. H. CLARK

Modern Turbine Oils

As already mentioned, the actual lubrication of turbine bearings is almost a minor function of the oil in a modern turbine. Due to the high speeds and the perfect balance of a turbine rotor and alternator, bearing loads are comparatively low, rarely exceeding 150 p.s.i., so that it is apparent that there is little difficulty in making an oil capable of withstanding such loading. The most severe loading takes place in the lubricating oil pump drive, particularly if worm gears are employed, but even here loads are not excessive and a light oil is quite suitable. There appears, however, to be a minimum viscosity of a turbine oil below which it is impossible to build up a full fluid film in the bearings, and thus to prevent metal to metal contact. This viscosity is probably around 40 sec Redwood at the operating temperature. It is desirable to use as low a viscosity oil as possible, as it more rapidly removes heat from the turbine journal, particularly at the h.p. end.

A high viscosity index is desirable as it reduces the change in viscosity due to temperature alterations to a minimum; this is particularly important in governing apparatus. In addition it must possess the ability to separate quickly from water, but undoubtedly the most important single property is that it must possess high resistance to oxidation.

Petroleum oils, being organic matter will, in actual use, oxidize or slowly decompose to form other substances. Regardless of the method or degree of refining, the type of crude used, or the addition of anti-oxidants, this will slowly, but none the less surely, take place.

Oxidation can be retarded but cannot be absolutely stopped. The important fact is that by careful design and operation of the turbine, by using the most suitable crude, by careful refining and the addition of suitable oxidation inhibitors, oxidation can be so retarded as to be of little danger.

Modern turbines with high spindle temperatures have greatly increased the risk of oxidation. Oxidation is a chemical reaction, and it has been shown that its rate is doubled for every 18°F rise in temperature, but below about 170°F the rate of oxidation of a good oil is negligible. Although the observed temperature of oil leaving the bearings rarely exceeds 170°F, the molecules of oil in actual contact with the turbine spindle may be subjected to temperatures as high as 500°F. Possibly the most severe conditions exist when the turbine is on barring gear, when only very small quantities of oil pass between the journal and the bearing.

It is impossible to exclude air from the lubricating system and without oxygen of course oxidation would be eliminated. It is possible, however, by a suitably designed system, to reduce the amount of air present to a minimum.

The third major factor in oxidation is the catalytic effect of metals. The greatest danger from this source is the presence of very finely divided iron oxides present in semi-colloidal form in the oil. These also help to stabilize emulsions, particularly in an oxidized oil.

The increasingly severe conditions under which a turbine oil must operate and the much more complicated lubrication systems, coupled with the greater use of the oil for purposes other than lubrication, led the major oil companies to devote much research to the production of higher quality, more stable turbine oils. Until the early 1930's practically all turbine oils were made by conventionally refining high quality

* Continued from page 303.

paraffinic crudes. Their limitations became more and more obvious as steam temperatures went up, and the solvent extraction method of refining was utilized for turbine oil production. This method produced oils in which sludge formation in service was practically eliminated and the life greatly increased. However, it was discovered that over extracted, these oils lost some of their natural resistance to the formation of soluble acidic oxidation products and when oxidation did commence, it progressed rapidly. This effect is shown in Fig. 8.

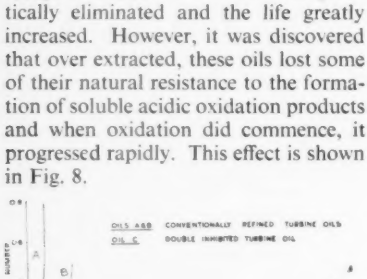

Fig. 8.

Intensive research resulted in the development of chemicals which, when added to a good solvent refined oil in very small quantities, retarded oxidation almost indefinitely under normal operating temperature conditions. Oils of this type after having been in service for periods up to 90,000 hours, still appeared in excellent condition.

It should be made clear, however, that the anti-oxidant must be compatible with the base oil and as a general rule must be developed to suit the particular oil concerned. The action of these additives is not yet fully understood, but it would appear that they act as chain breakers or de-activators and are thus gradually consumed in service. It is essential that the anti-oxidant is not decomposed by heat, nor must it be soluble in water or it will gradually be lost in the centrifuge discharge.

Corrosion

It is impossible to exclude moisture or water from the lubricating oil system, although some sets are much better than others in this respect. Corrosion is particularly severe in areas which are not oil bathed, especially in the upper parts of the oil reservoir. These areas are relatively cooler than the oil, and surface condensation takes place. After a time drops of moisture fall into the oil and carry with them finely divided iron rust. The particles are of two types, the finely-divided ferric oxide which is an active catalyst and the magnetic ferrous oxides which, because of their structure, coalesce into larger particles and are carried through the oil stream. They are often deposited in the bearings, where they may damage the babbit. Fig. 9 shows two turbine

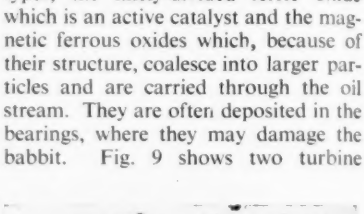

Fig. 9.
Turbine bearings showing rust particles embedded in white metal.

bearings and rust particles can be seen bedded in the white metal. They may also partially block the fine clearances in the governor gear.

This type of corrosion is usually termed primary corrosion, and is very prevalent in new turbines.

Secondary corrosion develops when a lubricant becomes oxidized and water soluble acids are formed. Under these conditions, when moisture condenses on the metal surfaces, corrosion is usually more active. Corrosion below the oil level can also occur and is particularly severe in its action on finely finished parts such as the governor pilot valve as shown in Fig. 10.

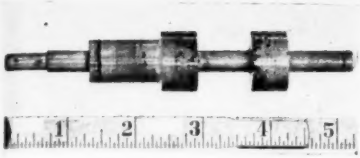

Fig. 10.
Turbine governor pilot valve showing excessive corrosion.

Primary corrosion is not due to oil deterioration, but secondary corrosion is a direct result of oil deterioration.

Fig. 11 illustrates an overspeed trip which failed to operate owing to the plunger being rusted in its guide, while Fig. 12 is a good example of corrosion which can take place on the bottom of an oil reservoir. Fig. 13 shows two baffles from an oil reservoir ventilating system which clearly illustrates excessive corrosion.

It is essential, therefore, that a suitable turbine oil should possess good metal wetting properties, but unfortunately it is polar bodies in a mineral oil which impart these properties, and a highly refined oil is almost entirely free of such matter. A used oil is of course rich in polar molecules, and therefore wets metal better. It has been fairly common practice in the past to add anything up to 10 per cent of a used oil to the new charge. This, however, greatly reduces the life of the new oil, and is therefore not to be encouraged.

Oil technologists have now developed a second type of additive which, when added to the turbine oil, has the beneficial effect of forming a very thin

Fig. 11.
Turbine over-speed governor which failed to operate due to corrosion.

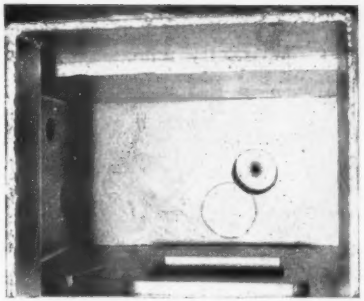

Fig. 12.
Interior of oil residue after cleaning. Corrosion at bottom left can be seen.

protective coating on the oil-bathed surfaces and yet does not affect the life of the oil. The rust inhibitors, as they are named, may be slightly acidic in nature, but do not themselves attack metals; but under laboratory conditions they usually raise the demulsibility value. After the oil has been in service for a short while, however, demulsibility is excellent. These inhibitors are not as a rule water soluble, but where water has been allowed to collect at the bottom of the reservoir, the protective film may be washed off and cannot under these circumstances be replenished until the surface is again oil bathed after removal of the water. Oils containing both anti-oxidant and rust inhibitor are sometimes called "double inhibited."

Fig. 13.
Ventilating baffles from a set in which the oil was severely oxidized. Note excessive corrosion by moisture and acid vapours.

It will be apparent, therefore, that although double inhibited oils greatly reduce or eliminate corrosion beneath oil-bathed surfaces, they cannot prevent it occurring elsewhere in the system, particularly above the oil level in the main tank. For this reason special paints have been developed which are unaffected by water, oil or organic acids.

Good examples of such special coatings are given in Figs. 14 and 15.

Fig. 14.
Looking down into interior of oil reservoir on a large turbine treated with special oil and water resisting paint.

A combination of an oil system treated in this manner and a good double inhibited oil ensures that corrosion can virtually be eliminated.

It might be interesting to compare typical inspection figures of the light type turbine oil as preferred by U.S. builders with the somewhat heavier oil recommended by British manufacturers (see Table I). These are both widely used double inhibited oils suitable for use in direct coupled turbo-alternators.

TABLE I
Typical inspections of turbine oils used in direct coupled turbo-alternators in the U.S.A. and Great Britain.

	Turbine Oil Light (Used in U.S.A.)	*Turbine Oil Medium (Used in Gt. Britain)*
Specific gravity	0.8628	0.8686
Colour, Robinson	1	1½
Closed flash P.M.	410°F	415°F
Pour point	15°F	15°F
Viscosity, redwood No. 1:		
at 70°F	282 sec	500 sec
at 140°F	65 sec	88 sec
at 200°F	41.5 sec	47 sec
Viscosity Index	114	109.5
Neut. No.	0.09	0.08
Conradson carbon, %	0.01%	0.03%
Demulsibility	220	270
Interfacial tension	30.8	31

Performance

There are now a number of inhibited turbine oils marketed which vary considerably in the base oils and types of additives used, but generally speaking the performance is similar. With conventionally refined, non-inhibited oils it was quite common to allow the neutralization value to rise as high as 2.0 mg KOH per g before oil removal, although in many cases harmful sludge, varnish, or acids had been formed. On the other hand, modern inhibited oils will last many times the life of the older oils before the neutralization value reaches 0.2 mg KOH per g. This is strikingly illustrated in Fig. 8.

Depending on the base oil used, the degree of refinement, and the inhibitors in use, some oils when new have a higher neutralization value than others, but this does not necessarily mean that the oil with the higher initial value is inferior to the other. It is the rate of change of acidity which is important. Unfortunately harmful sludge has often been formed before there is a noticeably marked rise is the neutralization value and for many years oil chemists and operators have been looking for a test

Fig. 15.
Interior of oil reservoir treated with special paint. Note absence of corrosion on upper part.

which will foretell when an oil is about to break down, so that it can be withdrawn before damage has been done.

The interfacial tension of oil against water is considered by many leading chemists to have immense value for this purpose. Briefly, interfacial tensions are related to surface tensions of liquids and are a measure of molecular attractive forces. Surface tension can be considered as an interfacial tension in which the interface is liquid/air. When the concentration of oxidation products increases in a specific oil sample the polar molecules at the water/oil interface increase with a corresponding reduction of the interfacial tension. It is therefore obvious that interfacial tension of an oil bears a relation to its emulsifying tendencies.

The most commonly used test at present to assess the condition of a turbine oil is the neutralization value, but this test only indicates the amount of acidic materials present and not the total decomposition products. The saponification number does, however, give a truer picture as it also takes into account other materials which can react with alcoholic potassium hydroxide. There is thus a closer correlation between interfacial tension and saponification number than between interfacial tension and neutralization value, as the interfacial tension test takes into account all kinds of polar oxidation products.

By the use of the Du Nouy tensiometer, the interfacial tension of a turbine oil against water can be accurately measured and as oxidation proceeds the value falls. This fall is apparent before any increase in neutralization value is observable, and it is thus possible to indicate by experience that oxidation has progressed to a stage where sludging can be expected. Oil can therefore be withdrawn from service before this point has been reached, and before there is a marked rise in the neutralization number.

Various observers have concluded by tests with a large number of samples over several years that a good oil starting with an interfacial tension of 30-35 dynes per cm can be expected to commence sludging when the value falls below 18 dynes per cm. At this point it is unlikely that there would be any appreciable rise in the neutralization value.

Fig. 16 shows interfacial tension correlated with saponification no., and Fig. 17 is a spot chart comparing interfacial tension with neutralization no.

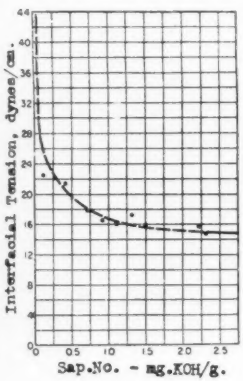

Fig. 16.
Interfacial tension—saponification number.

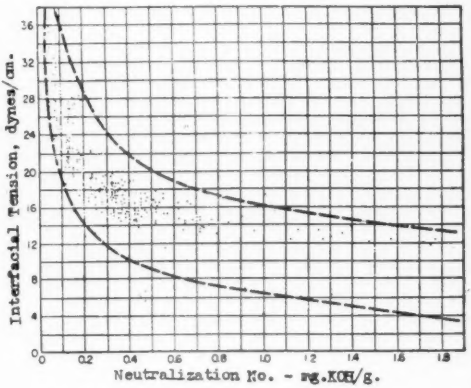

Fig. 17.
Interfacial tension—neutralization number.

These results were obtained with insulating oils.

It must be pointed out, however, that certain inhibitors, particularly rust inhibitors, can have a considerable bearing on the interfacial tension and that it is necessary to have some knowledge of the new oil before results obtained from the test can be truly assessed. Without such knowledge the interfacial tension of a used oil can be misleading. The test should be used with other well known tests when assessing the condition of an oil, and it is suggested that the following tests should be made on used oil samples at regular intervals:—

(1) Interfacial tension.
(2) Neutralization no.
(3) Viscosity.
(4) B.S. & W. (Bottom sediments and water).

The main value of B.S. & W. is to assess the amount of water present and also to test if the water is pure. This is particularly important where the cooler circulating water is salt or brackish.

Table II illustrates typical performance data on used inhibited turbine oils.

TABLE II
Typical performance data on used double inhibited turbine oils.

Size of Unit, K.W.	*Steam Pressure, p.s.i.*	*Steam Temp. °F.*	*Hours Service*	*Colour Robinson*	*Neut. No.*	*Sap. No.*	*Interfacial Tension*
39,400	1450	950	34,922	11	0.01	0.54	28.7
40,000	900	900	37,819	12½	0.03	0.21	29.2
12,500	300	650	59,409	7	0.05	—	—
15,000	600	850	73,355	11	0.06	0.48	30.5
25,000	600	850	64,495	12	0.06	0.55	29.4
50,000	1450	950	54,860	12	0.03	—	29.8
60,000	250	650	48,558	12½	0.02	—	30.1
25,000	600	850	62,149	11	0.06	0.48	28.7

Turbine Oil Maintenance

Efficient filtering equipment is now considered essential for all but the smallest turbines and the centrifuge is probably the simplest and most widely used. Correctly used, an efficient centrifuge plays an important part in extending the life of the lubricant and greatly reduces the risk of damage by foreign matter in the oil.

With older and less stable types of turbine oils, oxidation could be accelerated by the continuous churning and aeration in the centrifuge bowl. Modern oils are not harmed even by continuous centrifuging at elevated temperatures; in fact it is considered good practice to centrifuge at temperatures as high as 180 F because the higher the temperature the more readily do moisture and finely-divided solids separate from the oil.

Care should be taken not to operate at too great rates of throughput, and some centrifuges are much more efficient when operated at about 50 per cent of maximum capacity.

Where a conventionally refined oil is in use and is oxidized to a greater or lesser degree, water washing can be used. Many of the oil oxidation products are water soluble but not oil soluble, and act as binders for finely-divided solid oxidation products, atmospheric dust, and metallic oxides. The action of a warm water wash in the centrifuge is gradually to dissolve the water-soluble bodies leaving the solids deposited in the bowl. A small amount of water, possibly in the form of an emulsion in the case of a heavily oxidized oil, will be carried back into the oil reservoir with the centrifuge oil discharge. The water will then pick up more sludge and finally return to the centrifuge, where any solid matter will be retained and more of the sludge expelled.

This method of oil cleaning is particularly recommended where an oil is heavily oxidized and it is intended to drain the system and replenish with a new oil. Merely draining the oil from the system is not satisfactory as decomposition products are left behind, often in inaccessible places such as bearing housings and oil pipes. Cleaning the oil reservoir manually, does, of course, remove the greater part of these deposits, but unless the entire system is opened up for cleaning a considerable

amount still remains. If the system is now filled with a modern oil possessing high solvency properties and the centrifuge is used, practically all the deposits will be removed, but of course this reduces the life of the clean oil.

If on the other hand the set is kept in operation with the old oil in use and continuously centrifuged with a warm water wash at approximately 180°F, by far the greater amount of the sludge and solids are removed before the system is drained. There is thus much less risk of contaminating the new oil.

Water washing is not recommended nor is it necessary where a double inhibited oil is in use, as it may dissolve certain types of inhibitors.

When a new turbine is put into service it is advisable that an oil company's technical representative should be present with the builder's engineers to ensure that the set and oil are perfectly clean before the machine is put on load.

Views differ on the use of a flushing oil charge being used to clean up the lubricating oil system prior to the final oil charge being put in. The writers' views are that a flushing oil is undesirable as it is usually of lower viscosity and a poorer grade of oil than the final charge and it is impossible to remove it entirely after cleaning has been completed. Often as much as 50 gallons of oil will remain in the system when draining is completed. It is thought preferable to use the inhibited oil from the start, and with efficient cleaning devices it should be perfectly suitable, after being thoroughly tested, to put the set into service.

In conclusion, despite increasing severity of operating conditions, the oil technologist appears to be doing a satisfactory job by providing turbine oils capable of giving trouble-free operation over very extended periods of time. The user can help very materially by providing efficient oil maintenance and thus giving a good oil the best chance to last as long as the turbine.

LONDON BRANCH DANCE

The London Branch are holding a Buffet Dance (dress optional) at Manson House on December 1, 1950.

Dancing will take place from 8 p.m. until midnight. There will be a running buffet and bar.

All members of the Institute will be welcome, but tickets (which are 10s. each) are limited to 200, and early application is advised.

All applications for tickets should be made to the General Secretary, The Institute of Petroleum, and members are particularly requested to enclose a remittance with the application.

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135-TON TOWER FOR FAWLEY

Among the equipment of Esso's new £37,500,000 refinery at Fawley is a debutanizer tower weighing 135 tons. The tower, which is 113 feet long and 10½ feet in diameter, recently arrived at Southampton Docks in the *S.S. Volunteer State*, and was hauled by road on a thirty-two wheel double bogey trailer to the refinery site fifteen miles away.

Made of carbon steel plate one-and-a-half inches thick, the tower is designed to work at a temperature of 425°F.

Hauling the 135 ton debutanizer tower up a steep hill en route to Fawley.

AROUND THE BRANCHES

FAWLEY, LONDON, NORTHERN, SCOTTISH, SOUTH WALES, STANLOW, TRINIDAD

London Branch

An interesting session is planned which began last month (September 20) with a talk by F. W. Ellis, Anglo-American's farm trade co-ordinator. The subject was uses of petroleum in agriculture and the talk formed the first of a series on Petroleum in Industry. Other subjects to be covered in this series are Paint, Plastics and Rubber (November 20). Steel (January 23), Textiles (February 21) and Marine (April 18).

The President of the Institute, C. A. P. Southwell, M.C., will, on March 20, address the Branch on the planning of a large-scale production operation under desert conditions, while the subject of patents will be dealt with by Dr. J. T. Tyson, M.C., on December 20.

This month, on October 23, F. J. Erroll, Member of Parliament for Altrincham and Sale will speak on Petroleum in Parliament.

The first social evening of the session will take the form of a buffet-dance at Manson House on December 1.

To wind up the session Robert Flaherty's fine documentary film "Louisiana Story" will be shown at Unilever House on May 10.

Northern Branch

Northern Branch has completed arrangements for the session 1950/51, and has a full programme, which commenced with a paper on "Transformer Oils" by L. Massey, M.Sc.Tech., A.R.I.C. on September 19.

A meeting will be held each month at the Engineers' Club, Albert Square, Manchester. Two of the meetings are joint meetings, one with the Council of British Manufacturers of Petroleum Equipment, and the other with the Institute of Fuel. Papers on the following subjects will be given during the season: Jet Engines, Testing of Lubricants, Marine Lubrication, and Alloyed Oils.

A works' visit is being paid to Messrs. John Summers and Sons Ltd steelworks, Chester, on October 26, and on November 3, the annual dinner/dance will be held at the Midland Hotel, Manchester. A very enthusiastic membership is looking forward to an interesting session.

South Wales Branch

The first meeting of the 1950/51 session was held on September 7, 1950, at which a talk was given by F. J. Slee, of Shell-Mex and B.P. Ltd, on the subject of lubricating oils.

Mr Slee, in the course of his talk, gave a brief survey of the trends in, and the reasons for improvements in, lubricating oils during the past sixteen years; the use of additives, and such like. He described how, as a result of the recent war, and the resultant short supply of some materials, certain prejudices or fetishes had been overcome, such as the alleged necessity for certain blended oils, for particular purposes, to contain vegetable or fatty oils, the situation being met by oils without such materials; these continued to be used without complaint from the consumers.

The talk was of particular interest to individuals mainly concerned with the manufacturing side of the industry as it gave an insight to the viewpoint of the sales side. The talk was followed by a lively discussion, in which members of the sales personnel who were present participated, and many "off the record" points were brought out.

Scottish Branch

For its first meeting, on October 5, the Scottish Branch is to hear the President speak on the organization and development of a large-scale crude oil operation under desert conditions.

In November, two meetings are scheduled, the first being a film evening in Edinburgh and the second (in Glasgow on November 30) an address on distribution of petroleum products, by T. W. Lyle. On January 11 the meeting place will be Edinburgh and A. W. Jarman will speak on bitumen.

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LECTURES ON DISTILLATION

A course of eight evening lectures on distillation commences at the Sir John Cass College on Friday, January 12, 1951, at 6 p.m., continuing on successive Fridays. Intended for industrial chemists and chemical engineers, the syllabus covers basic theory, theory of fractionating column, column design, plant design and operation, auxilliary plant, and distillation processes—petroleum, alcohol, miscellaneous.

Lecturer is G. A. Dummett, M.A., A.M.I.Chem.E., and the fee for the course is £1. Enrolment forms are obtainable from the Principal of the College, Jewry Street, Aldgate, London, E.C.3.

"Elliott" Differential Thermometer. This new Beckmann type of adjustable thermometer is now being manufactured by H. J. Elliott Ltd, of the Treforest Trading Estate, Glamorgan. The advantages claimed are that it is very simple to adjust, and so robust that its transport presents no difficulty.

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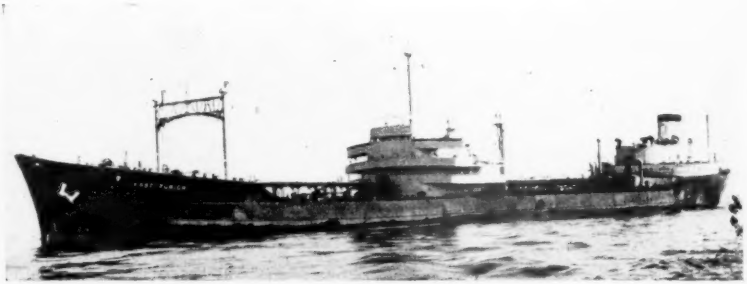
NEW SUPER TANKERS

A new type of 26,650 d.w.t. tanker with a designed speed of 17 knots is being planned by Esso. It is expected that ships of this type will be used for the shipment of crude oil from the Middle East to the new Fawley refinery.

These tankers represent a British modification of a type which has been successfully operated by the Esso fleet for the past two years. Overall length will be 628 ft, moulded breadth 82½ ft and depth 42½ ft, with a summer draft of 31 ft 11 in. They will be powered by double reduction turbines using high pressure steam from water tube boilers. Their pumps will be capable of handling 22,000 brl of oil an hour.



Esso Zurich is typical of Esso's 26,000-ton super tankers. She has been in service for two years.

PERSONAL NOTES

C. R. Middleton, G.M., F.Inst.Pet., has been appointed manager of "Shell" Refining & Marketing Co's Stanlow refinery in succession to **F. Mackley,** F.Inst.Pet., who has been transferred to London headquarters as assistant general manager.

Mr Middleton joined Shell-Mex Ltd in 1925 and from 1927 to 1938 was at the Suez refinery of Anglo-Egyptian Oilfields Ltd. as assistant chemist, chief assistant chemist, and refinery manager. In 1938 he joined the B.P.M. at the Hague and in 1940 became general manager of the Stanlow/Thornton refineries. From 1940 to 1945 he was manager of the U.B.O.T. refinery in Trinidad and, after a year with the Allied Control Commission, was appointed assistant general manager of Sarawak Oilfields Ltd. He was awarded the George Medal for "bravery and resource" during enemy raids on Shell Haven refinery in 1940.

Philip A. Singleton, formerly assistant director of Monsanto Chemical Co's foreign department in St. Louis, U.S.A., joins the British company this month (October) as assistant to the chairman and managing director.

D. H. Carter, M.Inst.Pet. (Head Wrightson Processes Ltd,) and **L. S. Dawson,** F.Inst.Pet. (The Oil Well Engineering Co. Ltd,) have been elected members of the Executive Committee of the Council of British Manufacturers of Petroleum Equipment.

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ANGLO'S £5000 GIFT

The sum of £5000 has been contributed by the Anglo-American Oil Company to the National Thanksgiving Fund, sponsored by the Lord Mayor of London, as an expression of Britain's gratitude to the Commonwealth and the U.S.A. for the £80 million worth of food gifts they have sent to the U.K. since 1940.

A. G. V. BERRY

It is with much regret that we record the death on September 1 of A. G. V. Berry, research superintendent to Lobitos Oilfields Ltd. Mr Berry entered the petroleum field in about 1901 as chemist to B. & R. Redwood and had served also the industry in Trinidad. He was an original Member of the Institute and was an *ex-officio* Member of Council as representative of the Stanlow Branch, of which he was honorary treasurer. At his funeral at Hawarden on September 5 the Institute was represented by J. S. Parker and Prof. F. Morton.

OIL IN PICTURES

In a fascinating booklet just issued by Shell-Mex and B.P. Ltd. 52 pictures and one sentence serve to illustrate how oil is produced in various parts of the world, refined, transported, distributed, and used in a variety of industries. The book has no title and the one sentence starts on the first page and ends on the last page, each phrase serving to emphasize the pictures printed with it on its particular page. It makes good educative material in an easily assimilated form.

S.I.M.A.

Officers of the Scientific Instrument Manufacturers' Association for the year 1950-1 are:—

President: H. H. Taylor.
Vice-Presidents: J. E. C. Bailey, C.B.E., A. W. Smith.
Hon. Treasurer: S. Borthwick.
Hon. Secretary: J. Rock Cooper.

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Kuwait Oil Company. Crude oil production in Kuwait during July 1950 amounted to 1,523,663 tons, total production for the period January 1 to July 31 being 9,118,603 tons.

DISTRIBUTION OF PETROLEUM PRODUCTS

By S. D. C.

In Great Britain refined petroleum products are received by ocean-going tankers at main ocean installations, from which distribution is effected by road, rail, or coastal or inland waterway vessels. Substantial quantities are handled by each method and the actual method adopted is determined by economic or physical conditions. The relative economies of each method are constantly changing. Water distribution is found to be the cheapest method where there are good facilities and fairly large quantities can be continuously supplied. At the present time, however, large capital costs are required for developing such facilities and moreover the cost of water transport has tended to increase rather more than that of other methods of distribution.

Deliveries from installations are of two sorts, (1) stock transfers to a depot or possibly another installation, and (2) movement direct to customer. There are tendencies in some quarters to increase the latter form of movement wherever possible, so effecting an economy by cutting out double handling. It is still, however, the normal practice for products to be stored for some time at a depot and the final delivery to customer made from a depot and nearly always effected by road.

On the road side, the most striking development of the last few years has been an increase in the size of vehicle used for petroleum spirit delivery. Until 1942 the maximum permissible gallonage for a road vehicle was 2500 gallons, and not more than 500 gallons could be carried in one compartment. The Petroleum Spirit Conveyance Regulations have since been relaxed to permit the carriage of 3600 gallons and the limitation in the size of the compartment has been altered to 600 gallons. In view of the large overhead expense that they carry it is necessary to work such road vehicles intensively, normally on double shift and sometimes on treble shift, to secure maximum economy in their use.

An advantage of the very large articulated road vehicle is that the trailers are interchangeable. This gives a convenient flexibility to distribution plans and enables the same motor unit to carry, for example, a spirit load one day, an asphalt load the next, and a heavy oil load on the third day, each trailer being reserved for its own particular grade. In passing, it should be noted that the trailers and all road vehicles used for carrying heavy oils and asphalt are equipped with heating coils to enable viscous heavy oils to be discharged, which is not practicable at normal temperatures. In the case of bitumen, which is solid at normal temperatures, heating is necessary for every loading and unloading. Bitumen tanks are equipped not only with heating coils but also with lagging in order to conserve heat as much as possible.

Motor Fuel

The transition to bulk distribution of motor fuel, as distinct from packages, which was to all intents and purposes complete before the outbreak of the second world war, had enabled the industry to educate the dealer and the commercial consumer into accepting the condition of a 200-gallon delivery as a minimum and for large commercial users the practice was, and still is, to order in much larger quantities. If there had been no limiting factors there is little doubt that considerable economies in distribution could have been planned with the growth in demand—both for private motoring and commercial use—and the average size of the individual delivery to the wholesale consumer progressively increased. There are, however, limiting conditions which circumscribe the process and render the

very large vehicle unsuitable for all operations: smaller vehicles of varying sizes are accordingly employed in accordance with the character of the demand to be met. The speed limit which is imposed on vehicles with an unladen weight in excess of three tons is the factor and the 1000 to 1200 gallon wagon is about the maximum size that can be built to retain the 30 m.p.h. qualification. It is probably the most useful and economic vehicle to operate to-day for normal delivery work. There is certainly no reason from the point of view of safety why larger vehicles should not be permitted to travel at 30 m.p.h. or, on properly designed roads, at even higher speeds.

Retail sales of motor spirit in cans has almost completely disappeared and may be said broadly to be confined to the special grades of spirit such as special boiling point spirits for cleaning, lighting plants, and other specialized uses. Retail dispensing to the consumer is effected almost entirely by the electrically-operated petrol pump at the private filling station which delivers to the private motorist's tank at a speed of approximately ten gallons per minute.

Lubricants

Distribution of lubricating oil, both to the motor trade and to the industrial consumer, is very largely effected in packages, the standard size being the 40-gallon drum. Smaller packages, ranging from the 10-gallon drum to the quart tin or bottle, are in demand for special requirements. The 40-gallon drum in the case of garage trade is often used as a substitute for a genuine bulk delivery, the contents of the drum being pumped off into another container from which smaller quantities may be dispensed in bulk. Apart from the heavy costs that are inevitably associated with package distribution the difficulties in handling encourage a changeover to bulk wherever the trade is of sufficient dimensions and bulk distribution is practicable. Bulk distribution to the motor trade and to the industrial consumer is largely effected by road wagon, the most normal type being the 600- or 1200-gallon vehicle with compartments arranged to suit the type of trade, while in some instances, notably for marine or heavy industrial users, the 3000-gallon bulk tanker (effectively the same type of wagon as the large white oil transportation vehicle) is used to advantage. There is also some distribution of lubricating oil in bulk to large consumers in rail tank cars, the rail cars being of 10 to 12 tons carrying capacity.

Kerosine

Kerosine is, not unnaturally, distributed in the main in small lots and the larger wagons which have been referred to would be used only for the movement of this product for occasional deliveries to large buyers and for transportation to depots. Nevertheless, the use of the small bulk tanker of the 1000-gallon type has been much developed in recent years and to an increasing extent such wagons are being fitted with mechanically operated pumps for unloading their cargo. There has, it would be fair to say, occurred almost a minor revolution in kerosine distribution since 1939. At that time the open wagon with a portable tank carrying 600 gallons, or even less, of two or even three grades of kerosine, and also packages of lubricating oil or even motor spirit cans, was largely in use for kerosine distribution. The kerosine was dispensed partly by hose but there was also a considerable trade effected by delivery into customers' small tanks by means of five-gallon measures, known in the trade as "Smalls" deliveries. To-day much of that kind of delivery has disappeared and kerosine distribution accords rather more closely with the bulk distribution of motor spirit. This has resulted from a decline in the use of kerosine for purely burning or illumination purposes but more notable is of course the considerable

increase in the demand for the vaporizing oil grade for agricultural use. The number of tractors in use in the United Kingdom increased sixfold in the war period, from 55,000 in 1939 to 341,000 in 1948, and a very large proportion of these operate on kerosine fuel. Subject to the limitations of steel shortages, users of agricultural kerosine have been encouraged to provide themselves with tanks in order to facilitate bulk delivery by hose, and mechanical pumping has become necessary because many such storages are for operational convenience and for economy installed above ground so that the normal gravity discharge method, which is characteristic of petroleum spirit delivery, is not practicable. The 30 m.p.h. 1000-gallon wagon is profitably and increasingly used for this side of the trade. Such vehicles are normally built to petroleum spirit specification so that they may be employed for the distribution of either product, but when used for petroleum spirit deliveries it is not permissible, and fortunately not necessary, for the mechanical pump to be used. The mechanical pump is activated by the engine of the lorry and the use of it for handling petroleum spirit is a contravention of the Petroleum Spirit Conveyance Regulations.

Packages

Distribution of petroleum products in packages does not play such a large part in road transport operations as it once did, but there are still a limited number of open wagons in service to which portable tanks can be affixed at will: these wagons are used for the distribution of special products which are handled in packages and of packed lubricating oil. There is however a tendency to employ the open wagon as a purely package distribution vehicle, working over a somewhat larger area than is usually covered by a delivery wagon based at a normal local inland depot.

Fuel Oils

The average size of road vehicle used for the delivery of black (fuel) oils is larger than that for motor spirit. Most black oil customers take large quantities at a time and the vehicle with a capacity of about 3000-gallons is usually found to be economic. Many 5-ton vehicles carrying 1200 gallons are also in use and 5-ton vehicles with a capacity of 1500 gallons are now coming into operation.

The distribution of black oils, which are used so much more generally in the large industrial undertakings and in the heavier industries, does not follow so closely the pattern of motor spirit and kerosine, the distribution of which is still based quite substantially on a number of comparatively small local depots. With black oils there is a considerably greater proportion of the trade dealt with by direct issues in large quantities by road, rail, or water from main terminals. Railheads subsidiary to these main terminals are employed to effect economy in delivery mileage, this being practicable with a non-highly-inflammable product in a way which would be neither desirable nor permissible with motor spirit.

Choice of Transport

Although the costs of all methods of distribution have increased considerably since 1939, road costs have probably increased less than those of the other methods, while the indications are that the heaviest increase has occurred in water costs.* The railway charges for oil transportation have for many years been constantly watched and frequently challenged by the alternative methods. For quite a considerable time before the 1939 war the "standard" rates were shown to be extremely vulnerable to road and water competition and the railway companies only preserved the considerable traffic they held by substantial concessions in the form of "exceptional rates." Even so, with "exceptional rates" (subject to wartime

increases) there is still a marked discrepancy in many instances between charges for carriage by rail of black oils and white oils, although the cost of rail conveyance cannot differ materially for the two types of traffic. The application of black oils rates to spirit traffic might in some cases serve to check the inevitable trend to road transportation or to the more formidable "direct delivery" competition to which reference has been made earlier on. This method is of particular significance when tenancy agreements for railway-owned land require all or a large proportion of the goods coming into a depot to be transported there by rail. Distributing companies faced with the necessity of new development for small inland depots will most certainly adopt a policy, prevalent even before the war, of siting such premises on land not subject to such restrictions but capable of varying methods of supply.

The standard size rail car was for many years governed by a legal limit of 14 tons, but rail cars may now be built above this limit provided they are of a suitable type. The 20-ton rail car is now becoming fairly common and cars may be built up to 25 tons if the bogey arrangements are adequate to spread the load. During the war many U.S. rail cars of 20 to 25-ton weight travelled over the British lines. The 20-ton size is a convenient and economical one for heavy fuel oil. Many existing sidings serving local depots are not, however, laid out to accommodate these larger cars and the expense of alteration would probably not be justified on any widespread scale.

One of the main improvements in rail car operation of the last few years is the increased use of trains made up entirely of cars carrying petroleum products, as opposed to the working of individual rail cars in mixed goods trains. The necessities of wartime had a good deal to do with this improvement. On the one hand air raid dangers led to the segregation of inflammable loads into special trains, and the heavy demands of the Air Forces made the adoption of this system of working practicable. The complete-train system has continued into the post-war period in meeting Air Ministry demands and such special demands as the coal/oil conversion programme, as well as for the stocking of depots. Probably one-third of all rail car movements is now in the form of complete train loads. During the war the east coast was closed to shipping, and depots lying on that side of the country, instead of being supplied by water, had to be fed by other means. This also was an important factor in developing the complete-train system. Air Ministry demands, combined with the restriction on coastal transport by water, led to the emergency building of over 4000 rail cars.

The improvement in the turn round and therefore the carrying potential of the rail car is increased by this method to quite a remarkable degree and the industry also entertains hopes that the advantage to the railway authorities in operation may be reflected in the future in reduced freight charges.

The two factors which are principally responsible for the present increase in rail car activity are the heavy increase in the demand for vaporizing oil and the coal/oil conversion programme. Twice as much is now being carried by rail compared with 1939.

There are many factors which have tended to narrow the gap between the costs of movement by water by coastal or inland waterway vessels and comparable movements by road and rail and some of these are beyond the power of the operating parties to modify. Coastal vessels are often subject to delays from wind and weather and inland craft are quickly affected by flooding or drought. Increases in general costs have also affected this method of transport more seriously than others. The expense of maintaining

vessels has increased by considerable margins and so have tolls and dues at ports and on the inland waterways. The construction of a water-fed depot was always costly in comparison with the simpler requirements of the road or rail-fed premises, but cheaper supply methods and distribution economies which flowed therefrom justified the outlay. Construction costs of any sort of depot under present day conditions are formidable and the basic differences are more than reproduced in a comparison of the costs of varying types. Development of the water-fed depot type is thus likely to be very carefully weighed before it would be adopted in favour of direct delivery from main terminal or the smaller less costly road or rail-fed unit.*

Servicing Aircraft

A development since the war has been the increased facilities for servicing civilian aircraft. The refuelling of aircraft at airfields is necessarily more expensive than the refuelling of road vehicles. A specialized type of tanker vehicle is required which, unlike normal road delivery vehicles, is equipped with pumps to transfer the spirit up to the aircraft tanks. Such vehicles are not usually suitable for operation on the public highway but have to be kept solely for their special purpose. Furthermore, it is usually found necessary to keep on each airfield sufficient vehicles to refuel a number of aircraft at the same time, although the occasions when a maximum number of aircraft may require service simultaneously may be infrequent. The normal short turn round time of an aeroplane on the ground, however, makes it necessary to have adequate refuelling facilities always available. The main supplying companies now have depots carrying aviation spirit and lubricants at all the main airports.

Pipelines

During the war an elaborate system of pipelines was constructed in Great Britain for the primary purpose o assisting in the movement of large quantities from the importing terminals on the west to the heavy war-time consuming centres on the east. In normal times however such a system of distribution is not economic in a country where distances are comparatively short and which is exceptionally well served with railways and roads as well as ports and inland waterways. The pumping of petroleum products through pipelines moreover gives rise to severe technical problems where changeovers have frequently to be made from the pumping of one product to another. A further characteristic of their use is the necessity for the establishment of large storage facilities both at the discharging and the receiving end.

It will be seen that the distribution of petroleum products is a complex process in which the methods employed must be constantly adapted in response to many different factors, including alterations in the pattern of demand, changes in the sources of supply, improvements in road vehicle and rail car design and operation and the ever changing costs of the various methods. The economic control of distribution calls for a flexible and imaginative organization which the oil companies of Great Britain have now brought to a high degree of efficiency and which will shortly be called upon to deal with the new set of problems presented by the vast increase in home refining now in course of development.

* This paragraph was written before the Chancellor introduced his 1950 Budget. The imposition of a purchase tax on commercial vehicles and the additional motor fuel tax of 9d per gallon which followed the Budget has probably increased road delivery costs by 7½ to 10 per cent, while rail costs have also soared as a result of the recently authorized increase of 16⅔ per cent on May 15 1950. These factors have not directly affected water transportation costs and the relationship between costs of the three methods is approaching once more to the pre-war pattern.

TRINIDAD PETROLEUM INDUSTRY IN 1949

In his report on the petroleum industry of Trinidad during 1949,* W. N. Foster, the Petroleum Technologist, states that there was little change in the scale of operations. Exploitation drilling on infilling locations failed to yield expected new production in some areas, but maintenance work, re-completions, and artificial lifting equipment enabled production to be increased slightly in comparison with 1948.

A costly exploration programme over widely spaced areas failed to discover any new oil areas.

Production and Drilling

Total crude oil production was 20,616,721 barrels (20,107,000 in 1948) and of natural gasoline 168,000 barrels (182,000).

Twenty-four rigs were in continuous operation and a total of 630,209 feet was drilled. The depth record was broken with 12,161 feet in the National Mining Corporations Otaheite test.

The number of wells completed during 1949 was 144, of which 130 were producers. The average number of producing wells was 2089, of which 616 were flowing wells, the remainder producing by artificial lift. Average daily production per well was 27 barrels compared with 27.3 barrels in the previous year.

Exploration

During the years 1945 to 1949 a total of 38 exploratory wells were commenced with a target depth of 8000 or more feet. Aggregate depth drilled to the end of 1949 was 344,117 feet, and while the outstep wells from producing areas were fairly successful, all the pure wildcat wells were unproductive and added nothing to proved crude reserves.

* "Petroleum Department. 1949 Administration Report." Trinidad: Government Printing Office, 1950. 36 C.

Refining

Trinidad Leaseholds Ltd. has announced its intention of extending its refinery by installing a 15,000 brl/day fluid catalyst cracking plant and a vacuum distillation column.

Petroleum chemicals manufacture was started during 1949 by Tricana Industrial Chemicals Ltd. and the Point Fortin vacuum asphalt plant of United British Oilfields of Trinidad Ltd. commenced operation in December.

Crude runs to stills were 12.6 per cent higher than in 1948, due to a larger volume of imported crude, and refinery details for 1949 are:—

	Tons
THROUGHPUT	4,204,302
OUTPUT:	
Aviation spirit	
100 octane	42,181
Other	87,298
Motor spirit	580,529
White spirit	295
Burning oil	63,574
Vaporizing oil	195,042
Gas and diesel oil	581,609
Fuel oil	2,414,576
Lubricants	345
Bitumen	54,847
Other products	24,906
Feed stock	22,322

Asphalt

Production of asphalt from the Pitch Lake totalled 145,160 tons in 1949.

Contribution to Revenue

During 1949 the oil industry contributed $19,504,071, or 33.4 per cent of Trinidad's revenue, and in addition $2,394,109 was collected as excise on petroleum products.

Also, a sum of $32,987,099 was disbursed in the colony by the oil industry, including $17,081,804 to employees, $4,488,089 to contractors, $4,336,776 for local purchases, and $7,080,430 in rents, private royalties, etc.

The c.i.f. cost of materials imported from the U.K. was $14,161,158, from Canada $516,130, from the U.S.A. $7,676,696, and from other countries $1,012,427.

A.S.T.M. ANNUAL MEETING

At the 53rd Annual Meeting of the American Society for Testing Materials held in Atlantic City during the last week of June, there were 23 technical sessions and over 500 meetings of technical committees. Registered attendance was 2134, a record.

Recommendations from technical committees resulted in 68 new specifications and tests and revisions in some 200 existing standards.

The total number of A.S.T.M. standards is now 1675, and five new technical committees have been organized since the last meeting, including those on Floor Waxes and Related Materials, and Radioactive Isotopes.

Awards of Merit

The first recipients of the A.S.T.M. Award of Merit for outstanding service to the Society were announced and include Howard P. Ferguson, chief o the Refinery Control Division of the Standard Oil Co (Ohio).

Atmospheric Pollution

A new technical committee on Sampling and Analysis of Atmospheric Pollution has been formed under the temporary chairmanship of Dr Louis C. McCabe, chief of Air and Stream Pollution, U.S. Bureau of Mines.

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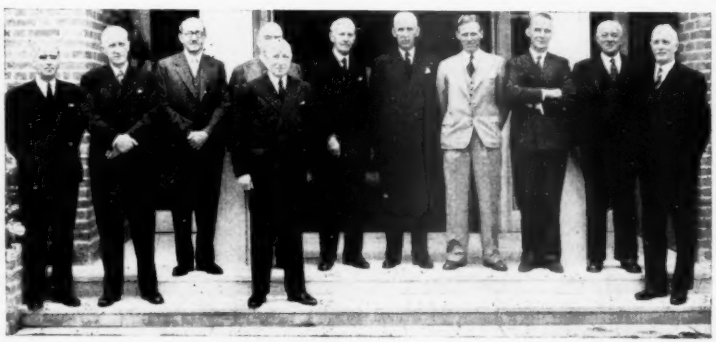
SUNBURY RESEARCH STATION EXTENSION

An extension to Anglo-Iranian Oil Company Research Station at Sunbury-on-Thames was recently opened by Sir William Fraser, chairman of the Company. This was the new block containing the Product and Inspection laboratories.

Sir William, declaring the building open, recalled the vast changes which had taken place since the station was opened thirty-five years ago, with a cellar serving as a laboratory. He illustrated how the costs of research had risen, pointing out that capital expenditure for 1930 was $2\frac{1}{2}$ per cent, and revenue expenditure 7 per cent of the equivalent 1950 figures. The photograph shows (left to right), J. M. Pattison, Sir Thomas Gardiner, Lord Alanbrooke, J. Jameson, Sir Hubert Heath-Eves, Sir Frank Smith, Sir William Fraser, Dr T. Tait, Capt. N. J. J. D'Arcy, Dr A. E. Dunstan. Maj. Gen. C. M. Smith.



OIL FILM WINS AWARD

At the International Film Festival in Venice, the Anglo-Iranian Oil Co's animated cartoon film "As Old as the Hills" shared the first prize in the Natural Science Film Class. The film, which is in Technicolor and runs for ten minutes, describes the laying down in prehistoric times of the great oil-bearing strata. It can be borrowed from the Petroleum Film Bureau, 29 Old Bond Street, London, W.1.

A.I.O.C. INFORMATION BOOKLETS

A new series of twelve booklets is being produced by the Anglo-Iranian Oil Co., giving information on the company's operations. So far four booklets have appeared—No. 1 "The Anglo-Iranian Oil Co's London Offices"; No. 2 "The British Tanker Co. Ltd."; No. 3 "Llandarcy Refinery"; and No. 6 "Scottish Oils Ltd."

OIL MEASUREMENT STANDARDIZATION

Work in connexion with the publication by the A.S.T.M. and the I.P. jointly of standard tables for the measurement of oil in bulk has now reached an advanced stage. Computation of the 14 tables, which will occupy some 1,100 pages, is completed and checking is in progress.

Points of detail in relation to matters concerning the mechanics of joint publication in the U.S.A. and in the U.K. only call for settlement. The A.S.T.M. Committee concerned with the American side of this work is meeting in New York early in October and Mr H. Hyams, chairman of the I.P. Committee, is attending that meeting in order that final decisions may not be delayed.

It is hoped that some of the tables will be ready for publication in time for the third World Conference in May 1951.

AGRICULTURAL PESTS

The life history of agricultural pests and the plants they attack is the subject of a series of ten short colour films which are being made by Shell.

Three of these films, on the Winter Moth, the Red Spider and the Raspberry Beetle, are completed, and are available free on loan, in either 16 mm or 25 mm from either Shell Chemicals Ltd, 112, Strand, London, W.C.2, or Petroleum Films Bureau, 29, New Bond Street, London, W.1. It is expected that the remaining films in the series will be ready for distribution within the next three months.

BOILER FUELS IN DIESELS

The Institute of Marine Engineers are reprinting the two papers by John Lamb, O.B.E.—*The Burning of Boiler Fuels in Marine Diesel Engines* and *Further Development in the Burning of Boiler Fuels in Marine Diesel Engines* as a single publication. Price will be 7s 6d per copy and the address of the Institute is 85 Minories, London, E.C.3.

FUEL EFFICIENCY EXHIBITION

Plant and appliances that promote more economical use of fuel of all kinds are being featured at an exhibition to be held at the City Hall, Manchester, from November 22 to December 2. Titled "Fuel Efficiency in Industry and Home," the exhibition is under the auspices of the National Smoke Abatement Society, of Chandos House, Buckingham Gate, London, S.W.1.

CHROMATOGRAPHY

Chromatography in industrial research is discussed in Bulletin No. 3 of the Sondes Place Research Institute, Dorking. The article is a useful and informative account of this method of identifying small quantities of chemical substances, and of its application.

PETROLEUM EQUIPMENT

A revised edition of the C.B.M.P.E's "Classified List of Petroleum Equipment" has been published. This new List is to be regarded as a supplement to the 1949 edition of the "Catalogue of British Petroleum Equipment," and shows the increased range of equipment available since the catalogue was published.

Enquiries for the List should be addressed to the Council of British Manufacturers of Petroleum Equipment, 79 Buckingham Palace Road, London, S.W.1.

Raw Materials Surveys. No. 2 in the Raw Materials Surveys series being issued by the Purchasing Officers Association is entitled *Petroleum.* In its eight pages it deals briefly with the industry and gives details of crude petroleum production (1947-8), reserves at the end of 1948, and U.K. consumption 1945-8. Price is 1s. 6d. and copies are obtainable from the Association at Wardrobe Chambers, 146 Queen Victoria Street, London, E.C.4.

Persian Production. Production of crude oil in Persia during July, 1950, was 2,801,000 tons, total production from January 1 to July 31, 1950, being 18,493,000 tons.

A.I.C.E. Meeting. The 43rd annual meeting of the American Institute of Chemical Engineers to be held at Columbus, Ohio, from December 3-6, will include in its programme symposiums on air pollution, glass manufacture, and phase equilibria.

B.O.F.E.C. British Oilfield Equipment Co Ltd announce that they have been granted by the Cameron Ironworks Inc. of Houston, Texas, a licence to manufacture in the U.K. a range of their products. These include well head assemblies, casing and tubing hangers, packers, blow-out preventers, valves, etc.

U.K. Silicone Manufacture. Albright and Wilson Ltd., for the last four years distributors of silicones in Great Britain for the Dow Corning Corporation of America, announce that they propose to manufacture silicones in the United Kingdom.

FORTHCOMING MEETINGS

INSTITUTE MEETINGS

The Role of Petroleum in European Recovery. Vernon Smith. At 26 Portland Place, London, W.1, 5.30 p.m. (*tea* 5 *p.m.*), October 11.

Stability of Mineral Oils in Toilet and Cosmetic Preparations. Dr. W. W. Myddleton. At 26 Portland Place, London, W.1, 5.30 p.m. (*tea* 5 *p.m.*), November 8.

London Branch

Petroleum in Parliament. F. J. Erroll, M.P. At 26 Portland Place, London, W.1, 6 p.m. (*tea* 5.30 *p.m.*), October 23.

Petroleum in Industry II. Paint, Plastics and Rubber. A. J. Goodfellow. At 26 Portland Place, London, W.1, 6 p.m. (*tea* 5.30 *p.m.*) November 20.

Scottish Branch

Films. At Edinburgh, November 2.

Distribution of Petroleum Products. At Glasgow, November 30.

Stanlow Branch

Planning a Large Scale Crude Oil Development in a Desert Region. C. A. P. Southwell. At Grosvenor Hotel, Chester, 7.15 p.m. October 19.

Carbon Black Manufacture. (With film.) L. W. Cabot, J. W. Edminster and C. A. Stokes. At Grosvenor Hotel, Chester, 7.15 p.m., November 15.

OTHER SOCIETIES

The High Speed Light Weight Diesel Engine. Com'r (E) J. H. D. Middleton. The Institute of Marine Engineers, London, 5.30 p.m. October 13.

Construction of Oil Tankers. H. Armstrong. Institute of Marine Engineers, at Constantine Technical College, Middlesbrough, 7.30 p.m., November 6.

Some Aspects of Semi-technical Scale Experimentation in Chemical Industry. Dr. R. Holroyd. Chemical Engineering Group. At Burlington House, London, W.1, 5.30 p.m., November 21.

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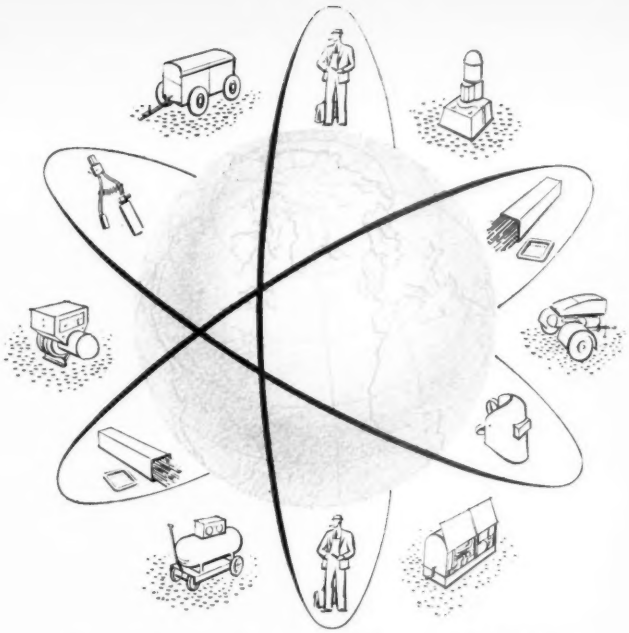

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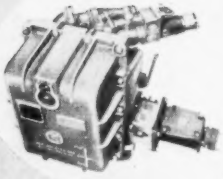

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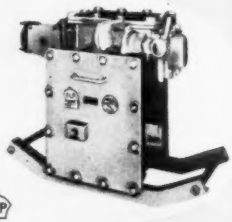

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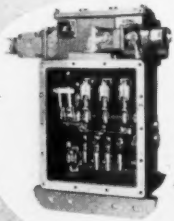

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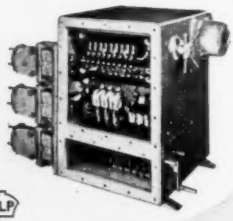

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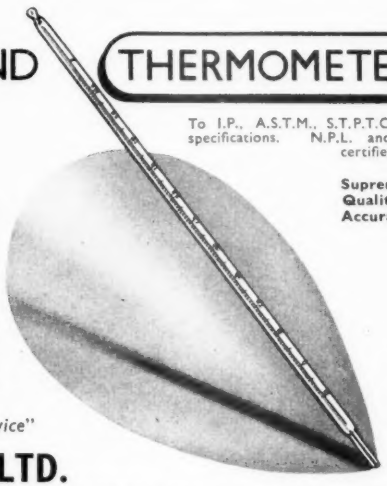

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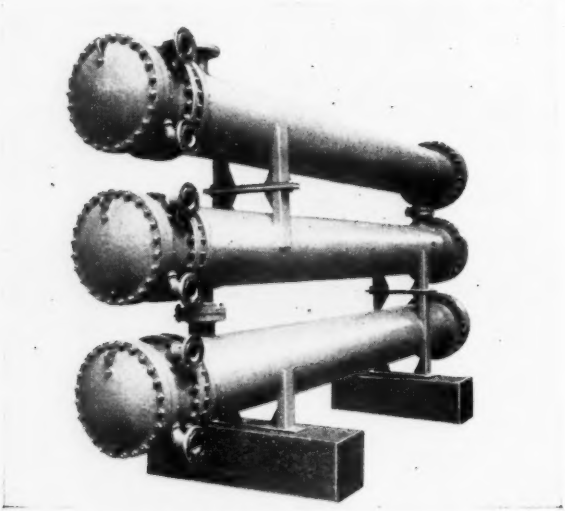

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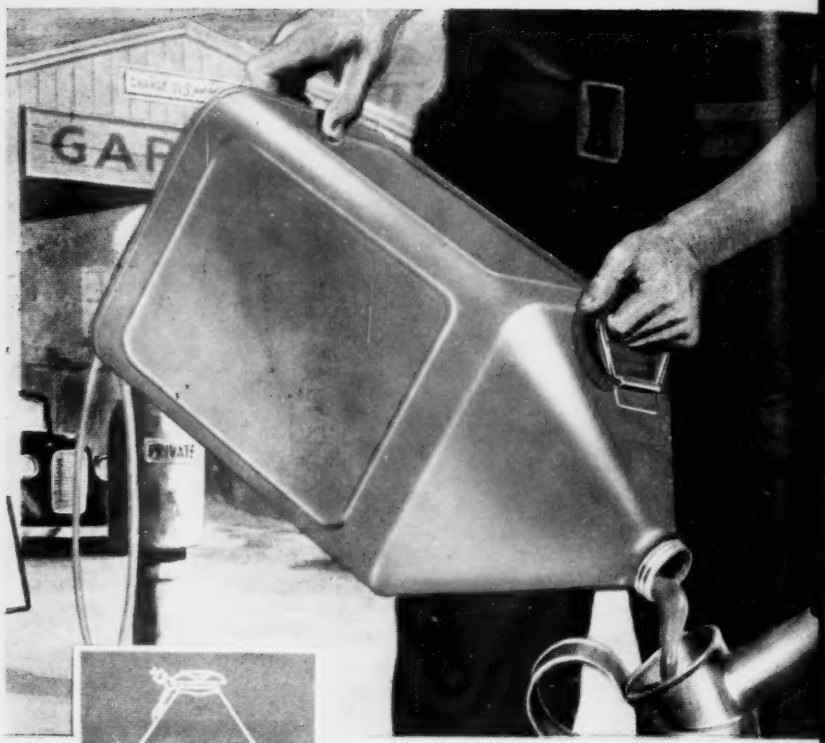

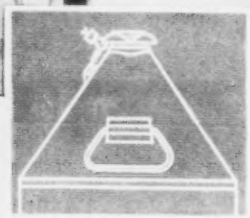

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